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GLOBAL TRADE COMPETITIVENESS OF INDIAN BUFFALO MEAT: TRENDS AND DETERMINANTS

Isha Sharma[1], Kashish Arora[2,*], Sunny Kumar[2], Priyabrata Bhoi[2] and Kamal Vatta[2]

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ABSTRACT

The study examines the performance of buffalo meat (HS-020230) trade globally and from India, assesses the export competitiveness of buffalo meat export, and identifies the determinants of export growth of buffalo meat from India. The study's empirical finding reveals that India has approximately 54% of the world's buffalo population and is one of the major buffalo meat suppliers to the international market. India's proportion of worldwide buffalo meat exports has increased from 3.34% in 2000 to 11.23% in 2020. During TE 2020, India exported 3052.4 million USD worth of buffalo meat to the rest of the globe, and the single-largest reported destination for India's buffalo exports was Vietnam, contributing 34% of India's buffalo meat export. The study determines India's competitiveness in the buffalo meat sector, and the results showed that China has RCA value greater than one, clearly indicating the strength of India in exporting meat to China. Buffalo population, total livestock population, and GDP of India have been identified as important determinants of the export of buffalo meat from India.

Keywords: *Bubalus bubalis*, buffaloes, buffalo meat export, determinants, RCA, Prais-Winsten algorithm

INTRODUCTION

The livestock sector is a crucial component of global economy with respect to income, employment, and foreign exchange earnings due to the demand for livestock products and it has increased tremendously due to sustained economic growth and rising domestic income. It is anticipated that the world population is expected to rise to over 8.3 billion by 2030, with an average annual growth rate of 1.1%, and it is critical to be prepared to provide enough protein and animal food for the rising population, particularly in developing nations (Wanapat and Kang, 2013). The rapidly growing world population will be consuming two-thirds more animal protein by 2050 than it does today (Naveena and Kirant, 2014). Human food consumption and animal food consumption of meat also increased from 10 kg per annum during the 1960 to 26 kg per annum in 2000, and further it is anticipated to reach 37 kg per annum in 2030 (Abodolereza and Racionzer,

[1]Symbiosis Institute of Operations Management, Nashik Symbiosis International (Deemed University), Pune, India

[2]Department of Economics and Sociology, Punjab Agricultural University, Ludhiana, India, *E-mail: kashish-aes@pau.edu

2009). In comparison, ICAR has simulated the same increasing pattern regarding per capita meat consumption, and according to the estimates of the report "ICAR's 2030 vision", per capita meat consumption would rise from 4.3 kg in 2000 to 10.1 kg in 2030 (Alexandratos and Bruinsma, 2012).

The domestic water buffalo (*Bubalus bubalis*) is an important animal in the agricultural economy of many tropical and sub-tropical countries (Suhail *et al*., 2009). It has the greatest potential for meat production of any domestic animal (Cockrill, 1994). Buffalo meat is equivalent to cattle meat in terms of physiochemical qualities, nutritional values, and palatability (Anjaneyulu *et al*., 2007). India holds the world's most prominent position in terms of buffalo production and population. With more than 58 percent of the world's buffalo, India has become one of the world's major exporters of bovine meat (Kaur *et al*., 2021). India's current meat export regulation restricts the export of cow, oxen, and calf meat. However, there is no restriction on slaughtering buffalo for meat (GOI, 2012; FICCI, 2013). Since the late 2000s, India's buffalo meat exports have grown significantly, with the country being the world's top beef exporter, owing to improved infrastructure, a vast buffalo population, and comparatively low price of Indian buffalo meat (Majumdar *et al*., 2016). The current growing trade scenario of the buffalo meat put question mark of that the nation can create a better position. Before planning, it is important to know the present trade scenario. Thereby, the present study provides current export and import position and the study also highlighted the destination markets of important buffalo meat exporters that briefly touches upon the prices received from the major importers. The study also analyses the major drivers of Indian water buffalo trade and give some policy options to strengthen it.

MATERIALS AND METHODS

The study is entirely based on the secondary data collected from an online database source. Data on pertinent variables like buffalo population, livestock population, buffalo meat production, and total meat production has been collected from FAOSTAT. Furthermore, the data on the export and import of buffalo meat extracted from UN Comtrade based on HS-6 classification. The trade flow of buffalo meat was enumerated by Harmonized System classification (HS code). The time frame selected for the present study was from 2000 to 2020 to examine the global and Indian export and import scenario of buffalo meat.

Furthermore, to better compare the results and formulate effective buffalo meat export policies, the study primarily focused on the most recent periods, 2018, 2019, and 2020, by taking Triennium averages (TE 2020). Globally, the demand was the highest for boneless frozen meat from bovine animals (HS 02023), accounting for nearly 17% of the global meat import. HS 020130 accounts for nearly 13% of the worldwide meat import followed by HS 020329 (11.6%) and HS 020319 (7.4%) (Figure 1). Indian buffalo meat exports consist of both fresh and frozen items. Under the fresh meat category, the country exports boneless meat of bovine animals (HS-020220), boneless bovine cuts (HS-020130), and edible offal of bovine animals (HS-020610). The items coming under the frozen category are the meat of bovine animals' cuts with bone (HS-020220), meat of bovine animals with boneless cuts (HS-020230), and edible offal of bovine animals with tongue and livers (HS-020621, HS-020622) and edible offal of bovine animals other than tongues. and livers (HS-020629). Of all the meat sub-categories, the four meat categories, namely meat of bovine animals

with boneless cuts (HS-020230), boneless bovine cuts (HS-020130), frozen swine cuts (HS-020329), and fresh swine cuts (HS-020319) accounts for approximately 50% of the global meat demand (Table 1).

On a worldwide scale, boneless frozen meat from bovine animals (HS-020230) accounts for the majority (89%) of the total meat exported by India with 3431.2 million USD, followed by frozen edible offal of bovine animals (HS-020629) which accounts for 6.3% of the country's total meat exports. Boneless frozen meat from bovine animals (HS-020230) has the most significant part of India's export and the tremendous demand for all the meat items. Therefore, this study was undertaken to examine its global trade performance and analyze India's competitiveness in terms of meat export.

Revealed Comparative Advantage (RCA) Index

RCA was introduced and popularized by Balassa (1965) to identify a competitiveness between the major exporting countries. The index measures normalized export shares, concerning the exports of the same industry in a group of reference countries. The RCA is calculated as follows:

$$RCA_{iw} = \ln\left[\left(\frac{x_{iA}}{X_A}\right)\Big/\left(\frac{x_{iB}}{X_B}\right)\right]$$

Where$_{XiA}$ and x_{iB} = the value of India's export of product 'i' and rival country's exports of product 'i' to a particular country group.

X_A and X_B = India's total merchandise exports and rival country's comparative merchandise exports to a particular country group. A positive value of RCA indicates a country's comparative advantage in a particular commodity against the rival country in a selected market.

Determinants of Indian water buffalo meat trade

To see the factors influencing the Indian water buffalo trade, Prais-Winsten Algorithm approach was used. In the first instance, a simple linear regression model was applied, but the value of Durbin-Watson statistic (ρ) was observed to be high and positive autocorrelation, while the value of coefficient of multiple determination (R^2) was to the tune of 0.91, clearly indicating the problem of serial correlation in the dataset. The Prais-Winsten algorithm was introduced as a solution to address the issue of serial correlation in data. This algorithm helps in eliminating the impact of serial correlation, which ultimately results in improved efficiency of the results.

Prais–Winsten Algorithm for determinants of trade flow of meat

Prais and Winsten (1954) are an improvement to the Cochrane-Orcutt method (Cochrane and Orcutt, 1949) for estimating time series regressions in the presence of autocorrelated errors. This transformation makes it possible to include the first observation in the estimation process, and thus estimators using transformed Prais-Winsten are much more efficient than those using Cochrane-Orcutt procedure (Magee, 1985; Magee, 1989). Prais-Winsten estimation procedure takes care of the serial correlation in a time series linear model, which leads to more efficiency in the result and makes it a particular case of feasible generalized least squares (Dielman, 2009). The Prais-Winsten method delivers exact Nonlinear least Square (equivalent to unconditional ML under normality) estimators. No normality requirement is needed for the Prais-Winsten method. The generalized form of the model is described in Equation (1):

$$Y_t = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \beta_3 X_{3t} + \beta_4 X_{4t} + \varepsilon_t \ldots (1)$$

Where Y_t is trade value at time t, β is a vector of coefficients, X_{1t} to X_{4t} is a matrix of explanatory variables, and ε_1 to ε_t is the error term.

The error term can be serially correlated over time and the Equation (2) is described below:

$$\varepsilon_t = \rho\varepsilon_{t-1} + e_t, |\rho| < 1, \text{ and } e_t \text{ is white noise.}$$

$$Y = \begin{bmatrix} y_1 \\ y_2 \\ \cdot \\ \vdots \\ y_t \end{bmatrix}, X = \begin{bmatrix} 1 & x_{11}x_{21}x_{31}x_{41} \\ 1 & x_{12}x_{21}x_{31}x_{41} \\ \cdot & \cdot \\ \vdots & \vdots \vdots \vdots \vdots \\ 1 & x_{1t}x_{2t}x_{3t}x_{4t} \end{bmatrix}, \varepsilon = \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \cdot \\ \vdots \\ \varepsilon_t \end{bmatrix} \text{ and } \beta = \begin{bmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \\ \beta_3 \\ \beta_4 \end{bmatrix} \ldots (2)$$

Where,

Y_t = Export Value of buffalo meat (Million USD) from year t = 1996 to 2020

X_{1t} = Buffalo Population (Million) from year t = 1996 to 2020

X_{2t} = Buffalo meat production ('000 t) from year t = 1996 to 2020

X_{3t} = Total Livestock population (Million) from year t = 1996 to 2020

X_{4t} = Gross Domestic Product (Rs Billion) from year t = 1996 to 2020

Transform the data using the autocorrelation coefficient "ρ" after which the transformed data are used in estimation. The procedures differ in their treatment of the first observation (x_1, y_1). The Prais-Winsten transformation matrix is given in Equation (3):

$$M_{PW} = \begin{bmatrix} \sqrt{1-\rho^2} & 0 & \cdots & 0 & 0 \\ -\rho & 1 & \vdots \vdots & 0 & 0 \\ \cdot & \cdot & & \cdot & \cdot \\ \vdots & \vdots & \vdots \vdots & \vdots & \vdots \\ 0 & 0 & \cdots & -\rho & 1 \end{bmatrix} \ldots (3)$$

Pre-multiplying the model in Equation (1) by M_{pw} results the following Equation (4) and (5):

$$M_{PW}Y_t = \beta_0 + M_{PW}\beta_1 X_{1t} + M_{PW}\beta_2 X_{2t} + M_{PW}\beta_3 X_{3t} + M_{PW}\beta_4 X_{4t} + M_{PW}\varepsilon_t \ldots (4)$$

or

$$Y^*_t = \beta^*_0 + \beta_1 X^*_{1t} + \beta_2 X^*_{2t} + \beta_3 X^*_{3t} + \beta_4 X^*_{4t} + \eta_t \ldots (5)$$

Where Y^*_t contains the transformed dependent variable values presented in Equation (6) and X^*_{1t} to X^*_{4t} is the matrix of transformed independent variable values in Equation (7), so

$$Y^*_t = \left[\sqrt{1-\rho^2}\, y_1,\ y_2 - \rho y_1, \ldots, y_t - \rho y_{t-1} \ldots (6)\right.$$

and

$$X^* = \begin{bmatrix} \sqrt{1-\rho^2}\sqrt{1-\rho^2}x_{11} & \sqrt{1-\rho^2}x_{21} & \sqrt{1-\rho^2}x_{31} & \sqrt{1-\rho^2}x_{41} \\ 1-\rho & x_2 - \rho x_{12} & x_2 - \rho x_{22} & x_2 - \rho x_{32} & x_2 - \rho x_{42} \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 1-\rho & x_t - \rho x_{1t-1} x_t - \rho x_{2t-1} x_t - \rho x_{3t-1} x_t - \rho x_{4t-1} \end{bmatrix} \ldots (7)$$

In Equation (5), η is the vector of serially uncorrelated errors. In practice, the value of ρ will be unknown and it must be estimated from sample data. The estimators of ρ used will be as follows Equation (8) and (9):

$$\hat{\rho}_{PW} = \frac{\sum_{t=2}^{t} \hat{\varepsilon}_t \hat{\varepsilon}_{t-1}}{\sum_{t=2}^{t} \hat{\varepsilon}_t^2} \ldots (8)$$

when all '*t*' observations are used, and

$$\hat{\rho}_{CO} = \frac{\sum_{t=2}^{t} \hat{\varepsilon}_t \hat{\varepsilon}_{t-1}}{\sum_{t=1}^{t-1} \hat{\varepsilon}_t^2} \ldots (9)$$

When t-1 observations are used the $\hat{\varepsilon}_t$, where the represents OLS residuals. Park and Mitchell (1980) showed that these two estimators minimize the error sum of squares conditional on β when t and t-1 observations are used, respectively, in the estimation process.

RESULTS AND DISCUSSIONS

We discuss our results in the following subheads. Firstly, the study has covered the

contribution of buffalo population and meat in the total livestock population and meat production to frame our argument. Further, the study revolved around the export and import scenario of the selected commodity (HS-020230). The study covered its trends in export, global trade destinations of buffalo meat and India's performance of the buffalo meat export. Lastly, the study end with the factors that affect the trade of Indian water buffalo.

Contribution of buffalo to the total livestock resources: Country-wise

Buffalo has been an integral part of livestock agriculture for over five thousand years producing milk, meat, hides and draft power (Nanda and Nakao, 2003). The worldwide livestock population was estimated to be 5169.8 million, with buffalo accounting for 3.9% (202.93 million) of the total livestock population (FAOSTAT, 2020), whereas India (a major buffalo meat exporter) accounted for nearly 21% of buffaloes to the total livestock herd of the country's resources which is approximately five times more than world buffalo population (Table 2). Population growth of buffalo is dynamic, with most of the growth in Asia (98%) whereas the population growth was merely 2% in Africa, America, Europe, and Oceania.

With only 2.4% of the world's geographical area, India accounted for 10.3% of the global livestock population. Among all the countries, China has the highest number of livestock resources (792 million) followed by India (534 million), Pakistan (203 million). When we make a comparison of buffalo population, India has the world's highest buffalo population, which accounts for 20.5% of the total livestock population and 54.1% of the global buffalo population, contributing 1.63 million tonnes of meat, accounting for 21.1% of total meat production in the country (FAOSTAT, 2020). The global buffalo meat output was 4.20 million tonnes, split across 32 nations, with Asia accounting for 91.5%, Africa accounting for 6.1%, and Europe and America accounting for the remainder. Buffalo meat accounts for 1.29% of the total meat produced globally (FAOSTAT, 2020). As per the FAO database, Pakistan, China, Egypt, and Nepal are the other significant buffalo meat-producing countries contributing 25.9%, 15.7%, 6.7%, and 4.5% of global buffalo meat production.

Global export and import scenario of Boneless frozen meat from bovine animals (HS-020230)

Meat is one of the most extensively consumed foods on the planet. Beef/buffalo meat accounts for approximately 1.3% of total meat production worldwide. Cow slaughter, however, is a societal taboo in India due to the religious value ascribed to cows by some tribes (Kandanuri, 2019). As a result, buffaloes are slaughtered to produce meat, generally known as "carabeef" in the global market (Majumdar *et al*., 2016). While buffaloes were traditionally used primarily for agricultural purposes, increased global demand for beef/buffalo meat, improved domestic industry infrastructure, and the emergence of a large number of private sector industry participants resulted in a tremendous increase in global frozen buffalo meat exports from 4875.5 million USD in 2000 to 24529.8 million USD in 2020; more than five times in two decades with an annual growth of 9.5%, while the global import increased at a growth of 8.9%, from 4757.4 million USD to 24326.4 million USD, again a growth of almost five times in the same period (Figure 2).

Trends in exports of buffalo meat from India

Buffalo meat is a dominant component of animal products exported from India. India's

proportion of worldwide buffalo meat exports has increased from 3.34% in 2000 to 11.23% in 2020. The share of India in global buffalo exports peaked in 2013, and as per USDA, India became the top exporter of buffalo meat in 2013, dislodging Brazil from the number one slot. The proportion of buffalo meat in overall agricultural export has likewise grown during the last two decades, which increased from 2.8% in 2000 to 7.6% in 2020. (Figure 3). Buffalo meat is mainly a byproduct of India's principal livestock-rearing method. Female buffaloes are generally raised for milk production, while male buffaloes have traditionally been utilized for draught, particularly in rural regions. However, as the usage of male buffaloes for draught decreases, an increasing proportion of male buffaloes are diverted for meat production (Kumar *et al*., 2012). Following the economic changes implemented in 1991, the potential for the export of animal products have expanded, and various such initiatives have been implemented to increase the export of buffalo meat. These activities are responsible for the dramatic growth in buffalo meat exports.

Export and import destinations of buffalo meat globally

Several variables influence trade destinations, including geographical and political closeness, disparities in comparative advantage, the degree of trade barriers, and so on (Kumar *et al*., 2012). The global meat export value is estimated to be 24,141.5 million USD for TE 2020. Major global exporters and importers of buffalo meat (HS 020230) have been listed in Table 3. The top ten nations accounted for nearly 90% of global buffalo meat exports and 76% of world meat imports (Table 3). Major buffalo meat exporting countries, namely Brazil, Australia, and India, accounted for more than one-half of the global meat export. Among different countries, Brazil bagged the topmost position exporting 5606 million USD worth of buffalo meat globally, accounting for 23.2% of the global buffalo meat trade during TE 2020.

Moreover, USDA projected that the export of Brazilian buffalo meat will reach to 2.9 million metric tonne by 2028 (Zia *et al*., 2019). Two major destinations of Brazil's buffalo meat export are China and Egypt together accounted for 70% of total Brazil's buffalo meat export during TE 2020. (Table 4). Zia *et al*., 2019 examined that with the increase in the authorization of Brazil's beef plant, the export of Brazilian buffalo meat to China will further expand in the next coming years. The Cerrado, a substantial tropical savanna region, and the Amazon contributed around 70% of China's Brazilian meat imports. Since 2019, China is said to have granted export licenses to 22 Brazilian slaughterhouses, 14 of which are in the Amazon and four of which are in Pará, Brazil's fifth-largest cattle herd (Joe, 2021). The second-largest exporter i.e., Australia exported 3893 million USD worth of buffalo meat and contributed 16.1% to the global buffalo meat export. China and USA dominate as the top two destinations for Australia's buffalo exports, accounting for 48.2% of Brazil's total beef shipments in TE 2020.

Although India leads in terms of world buffalo meat production, it is ranked in the third position, exporting 3052.5 million USD worldwide of buffalo meat and contributing about 13% to the global meat export, attributed primarily to a higher number of buffalo population in the country. United States is the fourth-largest exporter and the second-largest importer of buffalo meat, which exported worth of 2577.3 million USD, and it imported 2320.3 million USD worth of buffalo meat from the world to meet its meat consumption.

USA exported the buffalo meat at a price of USD 6 per kg while imported it at a cheaper of USD 5 per kg from the neighboring countries like Australia and New Zealand. Compared to exports from the United States and other major beef exporters, India's buffalo meat exports are low-cost (2.9 USD/Kg), reflecting perceived quality variations. India sells buffalo meat from, or non-productive dairy animals and its product does not fulfill the sanitary standards of several more sophisticated markets for beef imports (Landes *et al*., 2016). The relative perceived quality of Indian buffalo meat is reflected in the reported unit values for the frozen, boneless product exported by India and the frozen, boneless beef products shipped by other suppliers, including the United States (6.0 USD/kg), Argentina (4.5 USD/kg), Australia (5.0 USD/kg), Brazil (4.1 USD/kg) and New Zealand (5.1 USD/kg). However, the global financial turmoil, low price realization, and a Chinese ban on imports have reduced India's bovine meat exports, and the country lost its number one position to Brazil. Shipments have fallen due to lower demand in high-consumption markets, along with competitive rates offered by Brazil, the second-biggest exporter. The export of Brazilian buffalo meat has declined as there was devaluation of Brazilian currency in the international market, due to which price differential between India and Brazilian export has reduced translating India is less competitive (Suneja, 2016). The United States' export unit value is often among the highest (6 USD/kg) the top exporters, reflecting the perceived quality of US-fed beef and the product's relatively wide acceptability in developed-country markets. India, however, appears to be a significantly cheaper option for importers seeking low-cost beef.

The global buffalo meat import value is 22514.2 million USD for the TE 2020 (Table 3). China, United States, Japan, Egypt, and the Republic of Korea are the top contributors to worldwide buffalo meat imports. During TE 2020, China took the top spot, importing 8372.0 million USD worth of buffalo meat internationally, accounting for 37.2% of the global buffalo meat trade. The increasing demand for China's beef and slow growth in domestic beef production has increased the beef prices in the country which led to increase in import of beef from the neighboring countries.

Beef production has been a traditional activity and an essential contributor to China's economic growth. The low productivity of beef coupled with declining cattle inventory and increasing consumption of beef in the country has created a gap between the production and consumption in the country which ultimately increased the prices of beef in China. However, with this China become a major importer and consumer of beef in the international markets (Li *et al*., 2018). China, the biggest consumer of pork, has boosted beef and other meat imports as consumers seek alternatives following the deadly swine disease that's killed millions of pigs (Parija, 2019).

With this significant increase in beef imports, China gradually became a net importer of beef instead of the net exporter. Major beef suppliers to China in TE 2020 were Brazil (38.1% of total Chinese meat imports); Argentina (21.8%); Australia (15.8%); Uruguay (9.8%) and New Zealand (9.2%) (Table 5).

Since 1990, China imposed a ban on India's bovine meat import as there was a prevalence of rinderpest and Foot and Mouth Disease (FMD) in India. Again, in year 2016, China carried out field investigation in India and pointed out that FMD still existing in India and Indian meat did not meet the standards of OIE. Therefore, on January

12, 2016, China notified and suggested that India must carry out regionalization management of OIE standards.

India' performance in buffalo meat export (HS-020230)

Three main factors have facilitated India's emergence as a major beef exporter. First, the demand for Indian buffalo meat is quite high in the international market particularly low and middle-income developing countries as Indian buffalo meat has lower price realization than the remaining major meat exporting countries. Secondly, the country has highest livestock population as well as the lesser domestic demand of beef. Third, the well-established export-oriented slaughterhouses and packing and processing houses in the country. These factors together contribute to the development of beef industry in the country (Landes *et al*., 2016). As a result, India exported 3052.4 million USD worth of buffalo meat to the rest of the globe in TE 2020. The single-largest reported destination for India's buffalo meat is Vietnam, accounting for 34.4% of total buffalo meat exports in TE 2020, worth 1050.8 million USD. Malaysia is the second-largest destination, accounting for 11% of Indian buffalo meat exports worth 356.8 million USD, followed by Indonesia (9.43%), Egypt (7.31%), and China (6.89%) (Table 6). All the five major export destinations accounted for nearly 70% of the country's buffalo meat shipments. The major portion of Indian meat exports goes to relatively low-income markets that are more sensitive to price than quality and to markets with a preference for meat produced to halal standards. Notably, India's markets include nations whose sanitary standards allow meat imports from countries designated as FMD endemic by the World Organization for Animal Health. Soon, India's persistent challenges with FMD management will certainly prohibit it from getting access to more developed markets such as the United States, Japan, Canada, and South Korea.

The competitiveness of Indian buffalo meat w.r.t other countries has been evaluated using the Revealed Comparative Advantage approach. The Revealed Comparative Advantage (RCA) based on the Ricardian comparative advantage concept, is an index for calculating the relative trade performance of individual countries in a particular commodity. This index assumes that the commodity trade pattern mirrors inter-country differences in relative costs as well as in non-price factors, and hence we assume to "reveal" the comparative advantage of the trading countries. An array of factors contributing to movements in RCA includes economic and structural change, improved world demand, and trade specialization. In the recent study period (TE 2020), only China has RCA value greater than one, clearly indicating the strength of India in exporting meat to China. Nevertheless, some of the countries like Vietnam (0.71), Malaysia (0.67), and Indonesia (0.49) have RCA values less than unity but the Indian beef has more scope by expanding its export to these countries. India is also trying to capture the Asian countries like UAE, Dubai, Qatar, and Iran by providing Halal meat as per the norms of these countries.

Determinants of Indian water buffalo trade

In this section, an attempt has been made to identify the factors that steer the export of buffalo meat from India. The domestic buffalo population, domestic production of buffalo meat, total livestock population, and GDP of India have been included and given in Table 9 to explain the determinants of the export of buffalo meat from India. The average

buffalo meat production was 1425.6 ('000 tonnes), and an *A-priori* positive relationship was expected between the value of buffalo meat exported and the buffalo meat production. The production of a particular commodity essentially denotes the supply capacity of the exporting country and is expected to have a positive sign. GDP may be interpreted as the level of economic development and influence the consumption of the commodity, and the average GDP was found to be Rs 1347.6 billion.

Generally, it is expected to have a positive relationship with the exports from the country of origin. In addition, total buffalo and livestock population in the exporting country are also included in the model to measure the livestock production capacity. The average buffalo and livestock population was estimated to be 102.3 and 1094.6 million respectively. Therefore, it is expected to positively affect the value of buffalo meat exported.

Overall, the findings of Prais-Winsten regression support the specification in explaining India's buffalo exports flows to the trading partners, with signs of coefficient estimates mostly consistent with theoretical economic predictions and statistical significance at conventional levels. The effect of domestic buffalo meat production was observed to influence its export positively, but the coefficient was not significant. The higher buffalo population, which indicates the higher availability of units for domestic meat production, was observed to play a significant role in increasing the export of buffalo meat. GDP (Rs Billion) was used to reflect the degree of development for the exporting nation (India), and hence its predicted coefficient for the exporting country would be positive. The growth in GDP of exporting countries was found to have a positive and significant impact on the buffalo meat export, clearly indicating that the country's GDP will improve by 2.02% for every unit increase in buffalo meat export.

CONCLUSIONS

Buffalo has been and will continue to be a vital component of the socio-economic fabric, particularly in various Asian agrarian emerging nations. The buffalo meat industry is a significant part of the Indian economy. Because domestic consumer preference for buffalo meat in India is relatively low, the surplus output is accessible for export. The establishment of a sufficient exportable surplus and demand creation would allow India to capitalize on the benefits of rising global meat commerce. Furthermore, India is bordered by nations short on buffalo meat production and rely on imports to fulfill local demand. This gives India the option to sell buffalo meat to these countries. However, due to their high food safety and quality regulations, India cannot enter markets in wealthy countries. India's global supremacy in the buffalo meat production can well be translated into supremacy in exports if different food safety procedures to fulfill international hygiene requirements of high-paying markets like the USA and EU are rigorously pursued. There is also a need for a sustainable buffalo production system to meet the future demand of buffalo meat. The industry remains vulnerable to risks pertaining to social and political sensitivity. However, the government is addressing these issues by focusing on improving industry infrastructure through direct and increased private sector participation, implementing schemes like "salvaging and rearing of male buffalo calves" to ensure the availability of buffaloes for meat, and the development of a

Table 1. Export of different meat commodities from India at a global level, TE 2020.

HS Code		Commodity	Trade Value#	Share*	Unit value@
HS02		Meat and edible meat offal	3431.2	-	-
HS0201	HS-020130	Bovine cuts boneless, fresh or chilled	43.3	1.3	4.03
HS 0202	HS-020220	Meat; of bovine animals, cuts with bone-in (excluding carcasses and half-carcasses), frozen	0.01	0.0	2.22
	HS-020230	Meat; of bovine animals, boneless cuts, frozen	3052.5	89.0	2.93
HS 0203	HS-020319	Swine cuts, fresh or chilled, nes	4.27	0.1	2.89
	HS-020329	Swine cuts, frozen nes	21.8	0.6	2.82
HS 0206	HS-020610	Offal, edible; of bovine animals, fresh or chilled	2.18	0.1	2.23
	HS-020621	Offal, edible; of bovine animals, tongues, frozen	4.79	0.1	2.40
	HS-020622	Offal, edible; of bovine animals, livers, frozen	8.98	0.3	0.89
	HS-020629	Offal, edible; of bovine animals (other than tongues and livers), frozen	217.8	6.3	2.35
	HS-020649	Offal, edible; of swine (other than livers), frozen	0.24	0.0	2.09
	HS-020680	Offal, edible; of sheep, goats, horses, asses, mules or hinnies, fresh or chilled	0.24	0.0	4.05
	HS-020690	Offal, edible; of sheep, goats, horses, asses, mules or hinnies, frozen	4.11	0.1	3.46

#Million USD; @USD/Kg; *Share (%) of India to total meat export.

Table 2. Major buffalo meat-producing countries, TE 2020.

Major producing countries	Population, Million			Meat production, Million t		
	Buffalo population	Livestock population	Share (%)*	Buffalo meat production	Meat production	Share (%)#
India	109.87 (54.1)	533.92 (10.3)	20.5	1.63 (38.8)	7.7 (2.4)	21.1
Pakistan	40.01 (19.7)	203.28 (3.9)	19.6	1.09 (25.9)	4.49 (1.4)	24.1
China	27.24 (13.4)	791.91 (15.3)	3.4	0.66 (15.7)	77.5 (23.8)	0.8
Egypt	2.18 (1.1)	12.11 (0.2)	18.0	0.28 (6.7)	2.21 (0.7)	12.8
Nepal	5.28 (2.6)	27.3 (0.5)	19.3	0.19 (4.5)	0.41 (0.1)	46.3
Viet Nam	2.38 (1.2)	34.83 (0.7)	6.8	0.09 (2.3)	5.18 (1.6)	1.8
Philippines	2.87 (1.4)	22.35 (0.4)	12.8	0.07 (1.6)	3.26 (1)	2.0
Myanmar	4.02 (2.0)	54.58 (1.1)	7.3	0.05 (1.3)	3.42 (1.1)	1.5
Indonesia	1.07 (0.5)	67.09 (1.3)	1.5	0.03 (0.6)	4.78 (1.5)	0.5
World	202.93	5169.8	3.9	4.2	325.08	1.29

Figures in parentheses indicate the share of the country to the world.

*Share of buffalo population to the total livestock population of the respective country.

#Share of buffalo meat production to the total meat production of the respective country.

Table 3. Major exporting and importing countries of frozen buffalo meat HS 020230 at a global level, TE 2020.

Exporting countries				Importing countries			
Country	Trade Value*	Share (%)	Unit price (USD/kg)	Country	Trade Value*	Share (%)	Unit price (USD/kg)
Brazil	5606.3	23.2	4.1	China	8372.0	37.2	5.0
Australia	3893.0	16.1	5.0	USA	2320.3	10.3	5.1
India	3052.5	12.6	2.9	Japan	1377.2	6.1	4.1
USA	2577.3	10.7	6.0	Egypt	1291.2	5.7	3.5
New Zealand	1813.0	7.5	5.1	Korea	1129.5	5.0	5.6
Argentina	1786.2	7.4	4.5	Russia	781.5	3.5	3.6
Uruguay	1161.3	4.8	5.0	Other Asia	593.1	2.6	6.0
Paraguay	598.2	2.5	3.8	Indonesia	543.8	2.4	3.7
Canada	320.1	1.3	4.9	Malaysia	449.3	2.0	3.3
Poland	319.9	1.3	4.1	Israel	410.5	1.8	3.0
World	24141.5			World	22514.2		

*Million USD

Table 4. Major competitive and their destination markets of HS 020230 for India, TE 2020.

Exporting country	Destination markets	Trade value (Million USD)	Share (%)	Unit price (USD/kg)
Brazil	China	3594.1	64.1	4.5
	Egypt	456.8	8.1	3.1
	Iran	182.2	3.2	3.7
	Russian Federation	132.9	2.4	3.4
	Italy	101.6	1.8	6.3
Australia	China	1033.0	26.5	5.9
	USA	846.4	21.7	5.2
	Japan	703.9	18.1	4.2
	Rep. of Korea	539.9	13.9	5.2
	Indonesia	179.1	4.6	3.9

Table 5. Major importing markets of HS 020230 at a global level, TE 2020.

Destination markets	Exporting countries	Trade value (Million USD)	Share (%)	Unit price (USD/Kg)
China	Brazil	2597.1	38.1	4.96
	Argentina	1484.8	21.8	4.61
	Australia	1074.6	15.8	6.17
	Uruguay	666.9	9.8	4.78
	New Zealand	629.3	9.2	5.49
USA	Australia	859.3	37.0	5.27
	New Zealand	789.5	34.0	5.03
	Nicaragua	221.3	9.5	4.65
	Uruguay	183.6	7.9	5.91
	Mexico	83.3	3.6	4.82

Table 6. Major destination markets of India and competitiveness of different countries for HS 020230, TE 2020.

Exporting country	Total export (Million USD)	Share (%)	Unit price (USD/Kg)	RCA*
Vietnam	1050.8	34.43	3.09	0.71
Malaysia	356.8	11.69	2.98	0.67
Indonesia	287.9	9.43	3.39	0.49
Egypt	223.2	7.31	2.78	0.52
China	210.2	6.89	3.07	1.12
Iraq	163.5	5.36	2.45	0.25
Philippines	98.4	3.23	2.68	0.17
Saudi Arabia	94.7	3.10	3.06	0.17
United Arab Emirates	78.8	2.58	2.57	0.14
Myanmar	61.4	2.01	3.05	0.06
Algeria	57.9	1.90	2.86	0.08
World	3052.4	-	-	-

*For the year 2020.

Table 7. Summary statistics of key variables used in Prais-Winsten AR (1) regression analysis.

Variable	Mean	Std. Dev.	Min	Max
Trade value (Million USD)	1651.1	1627.1	93.8	4719.0
Buffalo population (Millions)	102.3	7.9	87.6	110.4
Buffalo meat production (‘000 t)	1425.6	163.0	1172.4	1656.5
Total livestock population (millions)	1094.6	194.0	797.2	1367.9
Gross domestic product (Rs Billion)	1347.6	852.0	366.6	2831.6

Table 8. Factors affecting the export of Indian water buffalo by using the Prais-Winsten AR (1) regression analysis.

Particulars	Coefficient	t	P>t
Constant	-17929.31 (6729.11)	-2.66	0.02
Buffalo population	301.93 (136.90)	2.21	0.04
Buffalo meat production	3.52 (3.38)	1.04	0.31
Total livestock population	-17.35 (6.88)	-2.52	0.02
Gross domestic product	2.02 (0.82)	2.46	0.02
rho	0.79		

Figures in parentheses indicate the standard error.

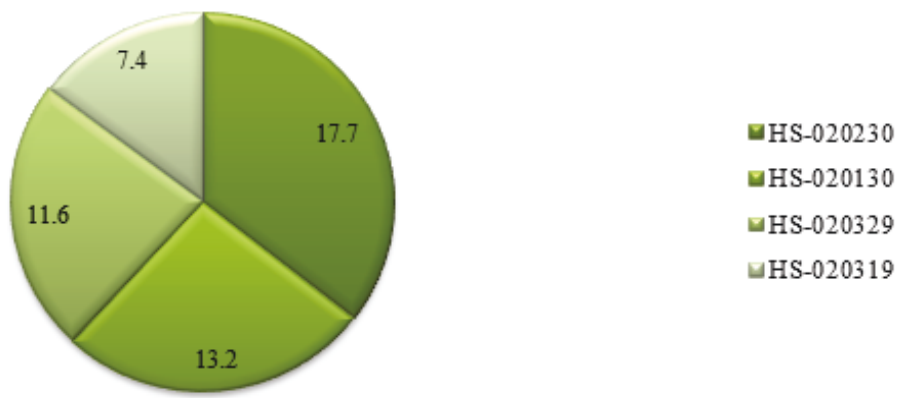

Figure 1. Demand (%) of different meat products at a global level, TE 2020.

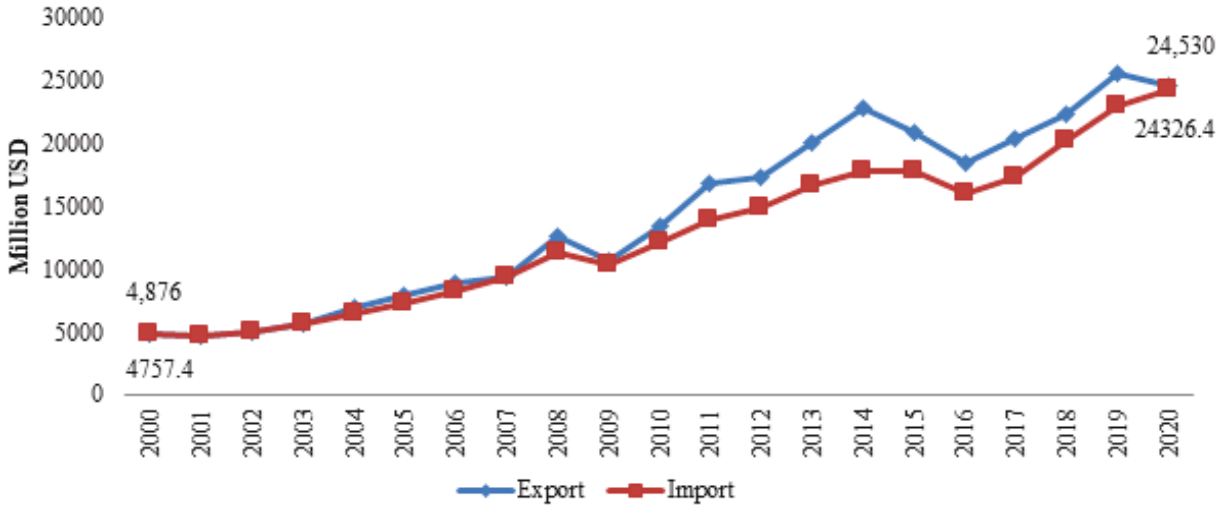

Figure 2. Global export and import scenario of meat product HS 020230.

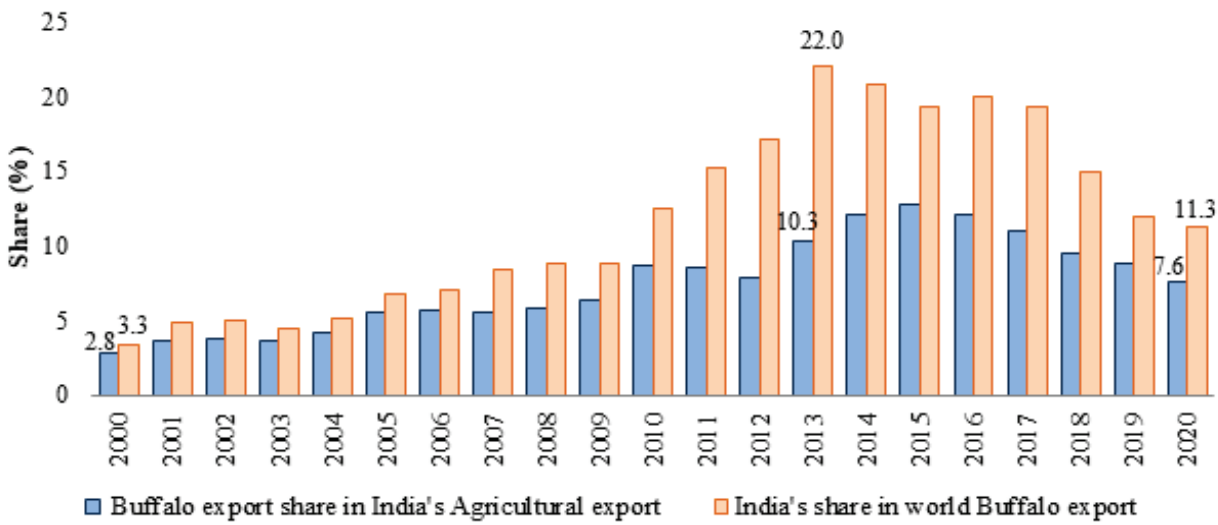

Figure 3. Trends in Indian buffalo meat exports.

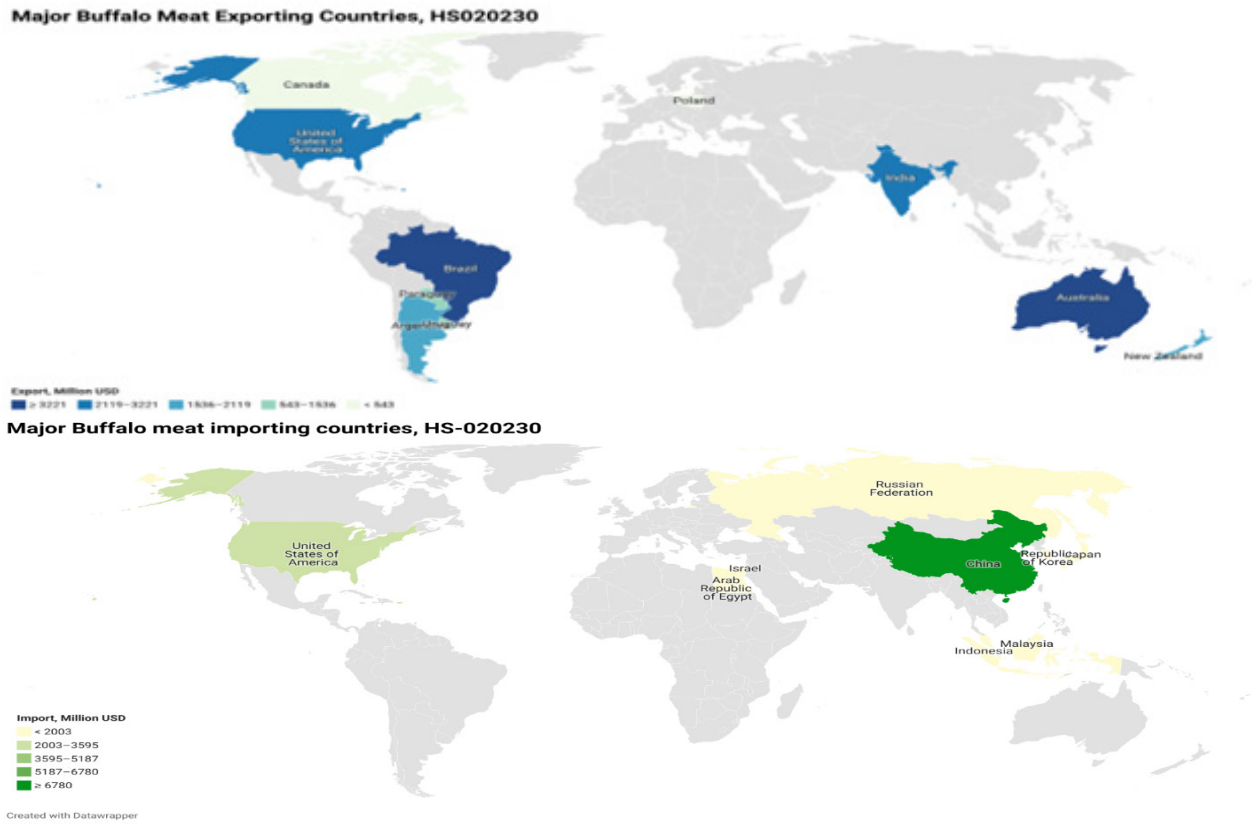

Figure 4. Major buffalo meat exporting and importing countries: At global level.

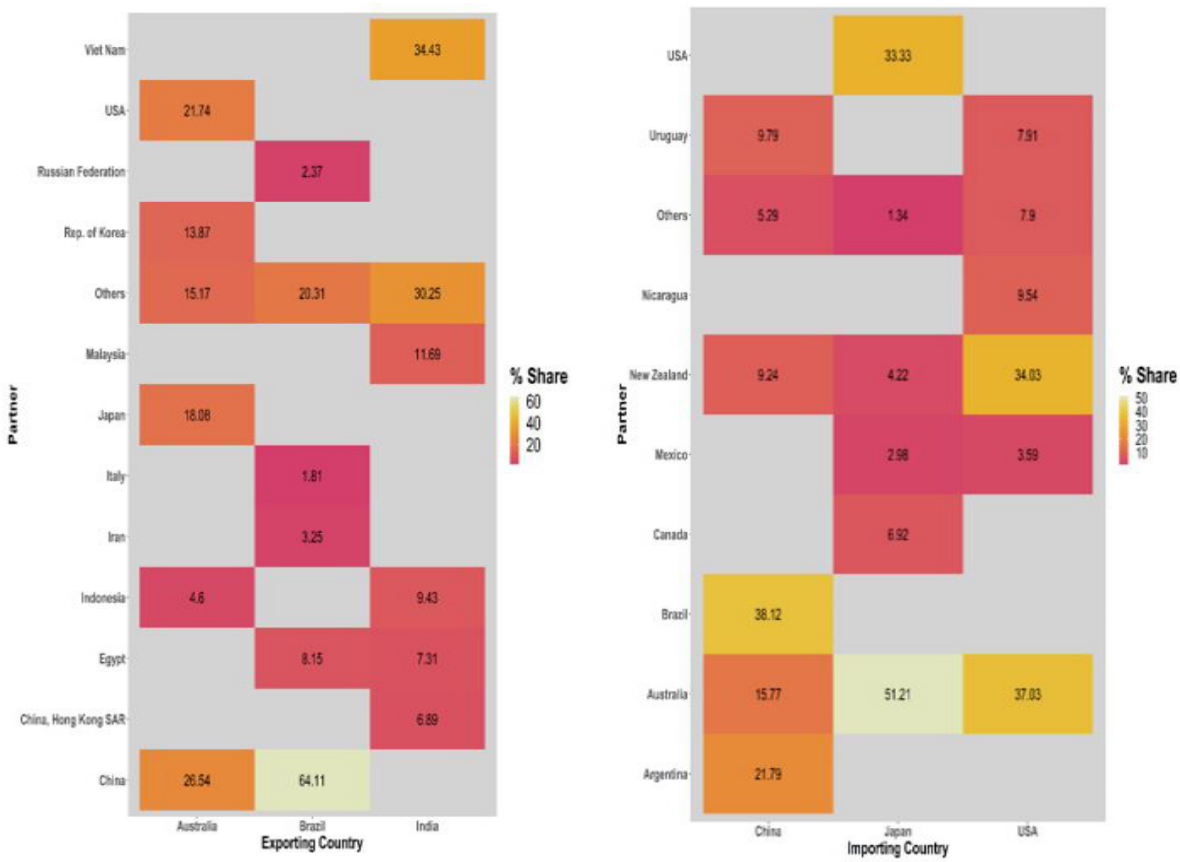

Figure 5. Major exporting and importing countries of HS-020230 and their destination markets.

broader regulatory framework to ensure better quality control. This, together with rising demand from developing nations and enhanced accessibility to newer areas due to improved meat quality and production, is expected to propel market expansion in the future.

REFERENCES

Abodolereza, A. and P. Racionzer. 2009. *Food Outlook: Global Market Analysis (December 2009).* Food and Agriculture Organization of the United Nations, Rome, Italy. 23-27.

Anjaneyulu, A.S.R., R. Thomas and N. Kondaiah. 2007. Technologies for value added buffalo meat products - A review. *American Journal of Food Technology*, **2**(3): 104-114. DOI: 10.3923/ajft.2007.104.114a

Alexandratos, N. and J. Bruinsma. 2012. *World Agriculture Towards 2030/2050: The 2012 Revision ESA Working Paper No 12-03*, Agricultural Development Economics Division, Food and Agriculture Organization of the United Nations, Rome, Italy. Available on: https://www.fao.org/3/ap106e/ap106e.pdf

Balassa, B. 1965. Trade liberalization and revealed comparative advantage. *Manch. Sch. Econ. Soc*., **33**: 99-123. DOI: 10.1111/j.1467-9957.1965.tb00050.x

Cochrane, D. and G. Orcutt. 1949. Application of least squares regression to relationships containing auto-correlated error terms. *J. Am. Stat. Assoc*., **44**(245): 32-61. DOI: 10.1080/01621459.1949.10483290

Cockrill, W.R. 1994. Present and future of buffalo production in the world. *In The Proceedings of the 5th World Buffalo Congress*, Sao Paulo, Brazil.

Dielman, T. 2009. A note on hypothesis tests after correction for autocorrelation: Solace for the Cochrane-Orcutt method?. *Journal of Modern Applied Statistical Methods*, **8**(1): 100-109. Available on: https://digitalcommons.wayne.edu/cgi/viewcontent.cgi?article=1485&context=jmasm

FAOSTAT. 2020. *STAT Database*, Food and Agricultural Organization, Rome, Italy.

FICCI. 2013. *Overview of The Indian Buffalo Meat Value Chain*. Federation of Indian Chamber of Commerce and Industry, New Delhi, India. Available on: www.ficci.com/spdocument/20331/Indian-Buffalo-Report.pdf.

GOI. 2012. *The 19thLivestock Census-2012 All India Report*, Ministry of Agriculture, Government of India, Krishi Bhawan, New Delhi, India.

Joe., T. 2021. China is increasing imports of Brazilian beef and the Amazon rainforest is paying the price for it. *Green Queen*, Available on: https://www.greenqueen.com.hk/china-is-increasing-imports-of-brazilian-beef-and-the-amazon-rainforest-is-paying-the-price-for-it/

Kandanuri, V. 2019. Indian buffalo meat exports: Issues of growth, instability, concentration. *Buffalo Bull*., **38**(3): 505-520. Available on: https://kukrdb.lib.ku.ac.th/journal/BuffaloBulletin/search_detail/result/390949

Kaur, A., S. Chopra, M.S. Sidhu and P. Kataria. 2021. Analysis of export potential of buffalo meat in India. *Buffalo Bull*., **40**(4): 609-623. Available on: https://kukrdb.lib.ku.ac.

th/journal/BuffaloBulletin/search_detail/result/414300

Kumar, A., S. Jee and C. Yadav. 2012. Export of buffalo meat from India: Performance and prospects. *Indian J. Anim. Sci*., **82**(12): 1578-1583. Available on: http://oar.icrisat.org/6584/1/IJAS_82_12_1578-1583_2012.pdf

Landes, M., A.A. Melton and S. Edwards. 2016. From where the buffalo roam: India's beef exports report. *Economic Research Service*, Department of Agriculture, Economic Research Service, USA. Available on: https://www.ers.usda.gov/webdocs/outlooks/37672/59707_ldpm-264-01.pdf?v=145.3

Li, X.Z., C.G. Yan and L.S. Zan. 2018. Current situation and future prospects for beef production in China - A review. *Asian Austral. J. Anim*., **31**(7): 984-994. DOI: 10.5713/ajas.18.0212

Magee, L. 1985. Efficiency of iterative estimators in the regression model with AR(1) disturbances. *J. Econometrics*, **29**(3): 275-287. DOI: 10.1016/0304-4076(85)90156-3

Magee, L. 1989. An edgeworth test size correction for the linear model with AR(1) errors. *The Econometric Society*, **57**(3): 661-674.

Majumdar, S., H. Jagnani and D. Jotwani. 2016. *Indian Buffalo Meat Export Industry: Trends and Outlook*. Investment Information and Credit Rating Agency of India Limited, New Delhi, India. Available on: https://www.icra.in/Files/Articles/SH-2016-1-ICRA-Indian%20Buffalo%20Meat.pdf

Nanda, A.S. and T. Nakao. 2003. Role of buffalo in the socioeconomic development of rural Asia: Current status and future prospectus. *Anim. Sci. J*., **74**(6): 443-455. DOI: 10.1046/j.1344-3941.2003.00138.x

Naveena, B.M. and M. Kirant. 2014. Buffalo meat quality, composition, and processing characteristics: Contribution to the global economy and nutritional security. *Anim. Frontiers*, **4**(4): 18-24. DOI: 10.2527/af.2014-0029

Parija, P. 2019. *China's Crackdown on Illegal Meat Puts India's $2-bn Trade at Risk*, Available on: https://www.business-standard.com/article/economy-policy/china-s-crackdown-on-illegal-meat-puts-india-s-2-bn-trade-at-risk-119120900078_1.html

Prais, S.J. and C.B. Winsten. 1954. Trend estimators and serial correlation. *Cowles Commission Discussion Paper*, University of Chicago, Chicago, USA.

Park, R. and G. Mitchell. 1980. Estimating the autocorrelated error model with trended data. *J. Econometrics*, **13**(2): 185-201. DOI: 10.1016/0304-4076(80)90014-7

Suhail, S.M., M.S. Qureshi, S. Khan and F.R. Durrani. 2009. Inheritance of economic traits of dairy buffaloes in Pakistan. *Sarhad Journal of Agriculture*, **25**: 87-93. Available on: https://www.aup.edu.pk/sj_pdf/INHERITANCE%20OF%20ECONOMIC%20TRAITS%20OF%20.pdf

Suneja, K. 2016. Bovine meat exports fall on China ban, Brazil competition. *The Economic Times News*, Available on: https://economictimes.indiatimes.com/news/economy/foreign-trade/bovine-meat-exports-fall-on-china-ban-brazil competition/articleshow/51707051.cms?from=mdr

Wanapat, M. and S. Kang. 2013. World buffalo production: Challenges in meat and milk production, and mitigation of methane

emission. *Buffalo Bull*., **32**(Sppl. 1): 1-21. Available on: https://kukrdb.lib.ku.ac.th/journal/BuffaloBulletin/search_detail/result/286501

Zia, M., J. Hansen, K. Hjort and C. Valdes. 2019. *Brazil Once Again Becomes the World's Largest Beef Exporter*. Economic Research Service, United State Department of Agriculture, USA. Available on: https://www.ers.usda.gov/amber-waves/2019/july/brazil-once-again-becomes-the-world-s-largest-beef-exporter/